Service Manual

Dial Flow Regulators

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1.0 General Safety Warnings

W1 Before using this device read through this entire instruction manual. As with all medical equipment, attempting to use this device without a thorough understanding of its operation may result in patient or user injury.

W2 Oxygen is not flammable, however, the presence of oxygen will drastically increase the rate and severity of combustion. Oil or grease in the presence of oxygen becomes highly combustible. Oxygen must never be allowed to contact oil, grease or other petroleum-based substances. Do not use oil or grease on oxygen regulators, flowmeters, cylinders, valves or other related equipment.

W3 Never administer oxygen while smoking or when near an open flame.

W4 Oxygen therapy may be a critical treatment. A regulated flowmeter should be used in strict accordance with the prescription and instructions of a physician. The effectiveness of supplemental oxygen therapy can only be determined by continuous monitoring of blood oxygen levels. It is essential that PaO2 or SpO2 monitoring is carried out when supplemental oxygen is prescribed.

W5 Never use medical gases from a cylinder without reducing the pressure through a suitable regulator intended for that gas.

W6 Always close the cylinder valve when the device is not in use.

W7 Never use oxygen as a pressure medium to purge obstructed pipelines or equipment, to operate pneumatic tools, or to build up any pressure in tanks.

W8 Never install a pin index regulator with more than one yoke seal between the cylinder valve and the regulator. Before attaching the regulator verify that the post valve is not already fitted with a yoke seal.

W9 Make sure that the pin-indexed or threaded fittings on the regulator inlet are compatible with the gas cylinder on which it is to be fitted. Never attempt to force an incompatible connection.

W10 Before removing a regulator from a cylinder, fully close the cylinder valve and release all gas from the regulator.

W11 Secure cylinders to a wall, stand or cart.

W12 The performance of the device may be affected if it is stored or transported in temperature outside of the range -20°C to +60°C.

W13 The threaded bull nose cylinder connection for Medical Oxygen and Medical Air may be the same, ensure that you have the correct cylinder for the application (UK only).

W14 The holes in the side of the body of the device are for venting gas in the event that the relief valve is activated. Do not obstruct these holes or interfere with the relief valve in any way.

W15 These regulators are designed for use for cylinder pressures up to 20 000 kPa (3000 psi/200 Bar), do not attempt to connect Carnét regulators to cylinders having fill pressures in excess of this value.

W16 Only personnel who have undergone the appropriate Carnét Medical training course should perform disassembly, assembly and testing of this equipment.

W17 Do not submerge in water or allow any fluid to enter the equipment. If you have reason to suspect that fluid or other ingress has occurred remove the device from use and contact the manufacturer.

W18 Never permit compressed medical gases to enter a regulator suddenly. Always open the cylinder valve slowly. Do not stand in front of a regulator outlet when opening the cylinder valve.

W19 Do not use or store oxygen equipment near excessive heat (>50°C or 125°F) or an open flame.

W20 Use only lubricants recommended by the manufacturer when servicing medical gas regulators. The use of lubricants other than those recommended by the manufacturer may result in fire or explosion.

2.0 Description of Symbols

Attention, see Instructions for Use

Use no oil

3.0 Requirement for Formal Training

Carnét Medical Marketing Ltd provide cost effective training courses for their full range of gas control products. Our policy on the need for formal training is given below.

Product Group	Part Number	Training Course
Regulators for Medical Gases	819 xxxx	Essential
Flowmeters with Integral Regulators	818 xxxx	Essential
Flowmeters	817 xxxx	Recommended
Micro Flowmeters	816 xxxx	Recommended
OASIS/Acupal	826 xxxx	Recommended

Key

Essential Mandatory. No attempt should be made to service, repair or test this equipment before the successful completion of the appropriate Carnét Medical course

Recommended Optional. We strongly recommend an appropriate Carnét Medical course but also acknowledge that someone with suitable qualifications and experience in the field of gas control products could undertake servicing, repair and testing of this product in conjunction with the relevant service manual.

4.0 Conversion Factors

Pressure: 100 kPa ≡ 1 Bar ≡ 14.5 psi

5.0 Approvals

Dial Flow Regulators are CE Marked in accordance with the Medical Device Directive (93/42/EEC) and meet the requirements of the following Harmonised Standards:

EN738-1.....Pressure Regulators and Pressure Regulators with Flowmetering Devices

6.0 Decontamination Certificate

A valid decontamination certificate should accompany all equipment returned to us for service or repair. In the interests of the health and safety of our employees, we may return to you, without further processing, any equipment that is received without a valid decontamination certificate.

7.0 Oxygen Compatibility

7.1 General

Oxygen is not flammable, but its presence will drastically increase the rate and severity of combustion. Materials that will not burn ordinarily in air may burn in elevated levels of oxygen; materials that will burn in air will burn more intensly.

Compressed oxygen is widely used in medical applications and presents a risk of serious injury if a fire occurs since it is often in close proximity to patients and clinical personnel.

Careful consideration is given to the design and manufacture of medical gas regulators to minimise the risks associated with high pressure oxygen. It is essential that the considerations applied to the original design and manufacture of this equipment are followed through in subsequent servicing and repair activities.

7.2 Standards

Medical equipment designed for use in oxygen atmospheres above 50 kPa is subject to the harmonised International Standard:

EN ISO 15001:2004 - Anaesthetic and Respiratory Equipment – Compatibility with Oxygen.

ISO 15001 outlines best practice in the areas of product design, material selection and product cleanliness and is a fundamental element of regulatory compliance and CE Marking for Oxygen control products.

The standard outlines two distinct levels of risk. Devices designed to operate at gas pressures of 30 Bar (3000 kPa) and above are considered to be of higher risk than devices used at gas pressures below this level. Devices used at pressures below 50 kPa (e.g. breathing circuits) are considered to offer a negligible risk and consequently are outside of the scope of the standard.

7.3 Adiabatic Compression

Adiabatic compression occurs when a gas is compressed rapidly without loss of heat from the system. When an Oxygen cylinder is opened the gas passes through the cylinder connector and compresses in the space immediately around the main jet. In certain circumstances it is possible for gas temperatures to exceed 1000^{o}C for very short periods of time and under such conditions small amounts of grease, oil or other debris will ignite. From this initial ignition a kindling chain can begin and progressively larger components with higher thermal masses can ignite leading to meltdown of the regulator in extreme cases.

7.4 Cleanliness

It is essential that devices designed to operate with Oxygen (and to some degree Nitrous Oxide, which also supports combustion) are assembled free from general contamination and in particular oil and grease (hydrocarbons). Oxygen regulators are designed for use up to gas pressures of 20 000 kPa (200 Bar) and therefore offer a significant risk of ignition.

Hydrocarbons fluoresce when exposed to a source of UVA light and a suitably powered light source with a wavelength of between 315nm and 400nm offers an excellent way of ensuring that workplace and product are not contaminated.

The following can be considered good practise:

- Always wash, rinse and dry your hands carefully before and after servicing regulators
- Do not use barrier or other hand creams
- Use Isopropyl Alcohol (IPA) for cleaning components
- Use only lint-free wipes for cleaning
- Clean down the work area using IPA and lint-free wipes before you begin
- Lay down a lint-free wipe as a work area to lay components out
- Check the work area for hydrocarbon contamination before you start
- Use an ultraviolet light source to inspect high pressure components for particulate and hydrocarbon contamination before re-assembly

8.0 Product Description

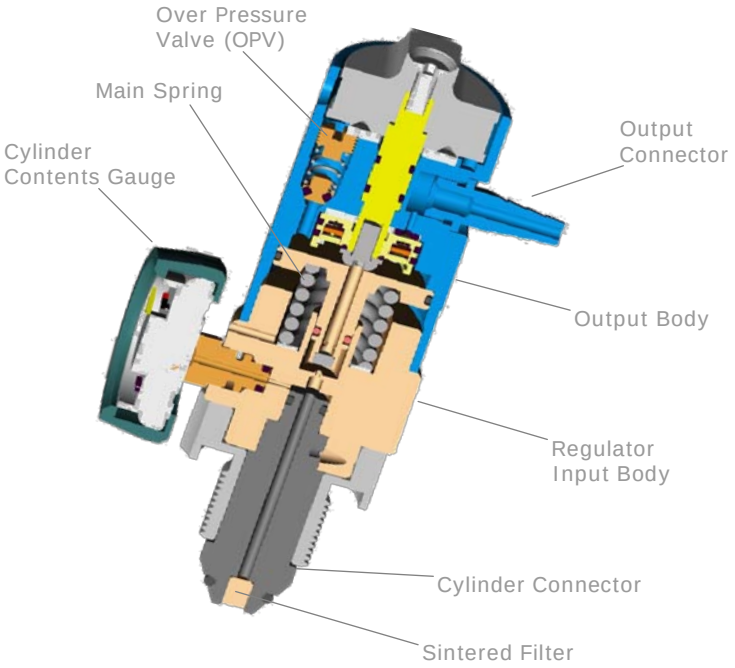
The Carnét range of dial flow regulators provides a safe and convenient way of providing oxygen therapy to a patient directly from an Oxygen cylinder.

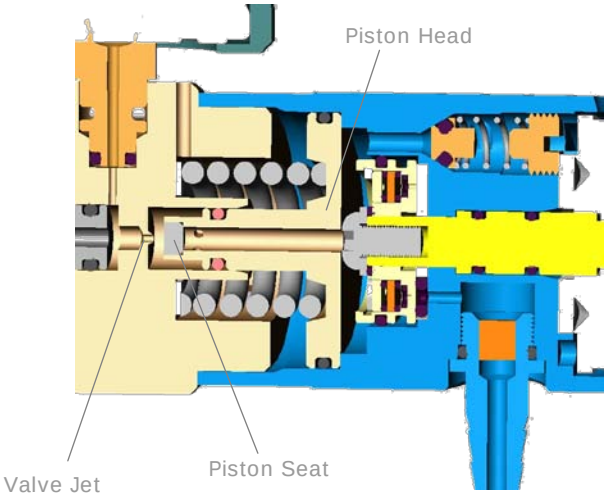
Gas from a high pressure cylinder enters the regulator through a cylinder connector with an integral 40 micron sintered filter. The gas passes through the main jet and piston shaft to the space above the piston head and exhausted to atmosphere through the output connector. The pressure build up in this space acts on the piston head (Pressure = Force/Area) and begins to move the piston down against the main spring, which closes the gap between the seat and the main jet, increasing the impedance to gas flow through, and pressure drop across, the main jet. This in turn reduces the pressure acting on the piston head. The piston will reach a state of equilibrium based upon the forces acting on it (i.e. main spring, gas pressure on piston head, gas pressure on piston seat). The exact position of the piston above the jet will be dependant upon the gas flow.

The output pressure is then fed through an orifice to derive a particular flow. The device has 11 different flow positions, any one of which can be selected by the user depending upon the clinical requirement.

An Over-Pressure Valve (OPV) prevents dangerous levels of output gas pressure and is factory set at 5 Bar (2 Bar for Micro Flow). In the event of excessive output pressure, a spring-loaded piston lifts and safely exhausts gas to ambient. No attempt should be made to adjust or tamper with the OPV.

The Carnét range is of modular construction and a variety of different cylinder (input) connections and flow ranges are available, refer options table in Section 9.





9.0 Product Options

	Part Number	Cylinder Connection	Output Connection	Outlet Pressure
Oxygen	818-0002	Pin Index	Tubing Nipple	Range A
	818-0005	Pin Index	Tubing Nipple	Range C
	818-0009	Pin Index	Tubing Nipple	Range D
	818-0031	Pin Index	Tubing Nipple	Range E
	818-0001	UK Bull Nose (G5/8)	Tubing Nipple	Range A
	818-0006	UK Bull Nose (G5/8)	Tubing Nipple	Range C
	818-0010	UK Bull Nose (G5/8)	Tubing Nipple	Range D
	818-0030	UK Bull Nose (G5/8)	Tubing Nipple	Range E
	818-0016	UK Bull Nose (G5/8)	DISS humidifier fitting	Range D
	818-0013	Benelux Bull Nose	DISS humidifier fitting	Range D
	818-0014	Benelux Bull Nose	Tubing Nipple	Range D
	Dial Flow Regulators with auxiliary 60 psi gas outlet			
	818-0017	Pin Index	1) Tubing Nipple for flowmeter 2) Schrader BS5682 socket for 60 psi auxiliary outlet	Range D
	818-0027	Pin Index	1) Tubing Nipple for flowmeter 2) Schrader BS5682 socket for 60 psi auxiliary outlet	Range C
	818-0018	UK Bull Nose (G5/8)	1) Tubing Nipple for flowmeter 2) Schrader BS5682 socket for 60 psi auxiliary outlet	Range D
	818-0020	UK Bull Nose (G5/8)	1) Tubing Nipple for flowmeter 2) Schrader BS5682 socket for 60 psi auxiliary outlet	Range C
	818-0021	Benelux Bull Nose	1) Tubing Nipple for flowmeter 2) 1/4G Female threaded for 60 psi auxiliary outlet	Range D

	Part Number	Cylinder Connection	Output Connection	Outlet Pressure
Air	818-0025	Pin Index	Tubing Nipple	Range D
	818-0028	Pin Index	1) Tubing Nipple for flowmeter 2) Schrader BS5682 socket for 60 psi auxiliary outlet	Range D
	818-0024	UK Bull Nose (G5/8)	Tubing Nipple	Range D

10.0 Flowmeter Ranges

Position	Range A	Range C	Range D	Range E
1	0.02	0.10	0.5	0.01
2	0.03	0.20	1.0	0.02
3	0.05	0.30	1.5	0.03
4	0.08	0.40	2.0	0.04
5	0.12	0.50	3.0	0.05
6	0.20	0.60	4.0	0.06
7	0.30	0.70	5.0	0.07
8	0.50	0.80	6.0	0.08
9	0.75	0.90	8.0	0.09
10	1.0	1.0	10.0	0.10
11	3.0	1.5	15.0	1.0

Flows given in Litres per Minute (l/min)

11.0 Specification

General	
Operating, Storage and Transport Temperature Range	*-20°C to 60°C*
Standard Warranty	*1 Year*

Performance	
Maximum Input Pressure	*200 Bar (20 000kPa)*
Minimum Input Pressure	*10 Bar (1000 kPa)*
Flow Accuracy	*±10% of setting at 1 lpm and above, ±20% of setting below 1 lpm*
Effect on accuracy as a result of:	
i) varying inlet pressure	*Typically less than 15% change across the input pressure range 200 to 10 Bar*
ii) varying outlet resistance	*Less than 1% of reading up to 5kPa (50cmH_2O) back pressure*
iii) varying temperature	*Typically 0.2% of reading per degree Celsius*

12.0 Inspection and Maintenance Periods

12.1 Periodic Inspection (Annual)

Regulators should be visually inspected on an annual basis to:

- ensure that there is no obvious damage
- check that the cylinder seal is in place and in good condition
- Check that the cylinder contents gauge is reading zero when not connected to a cylinder and offers an appropriate reading when connected to a cylinder (i.e. green area of the gauge for a full cylinder)
- Listen for obvious leaks when the regulator is connected to a full cylinder
- Check the accuracy of the flow rate at the highest flow setting (refer Section 14 for guidance)
- make sure that device does not need servicing (Service Due date)

12.2 Functional Check for Micro Flowmeter Ranges Only (2 Years)

Micro flowmeters (i.e. Range A and Range E devices) should be checked for function every 2 years in accordance with Section 14.

12.3 Full Service (4 Years)

Strip down service and full functional check. Requires suitably trained personnel, appropriate workshop conditions and specialist equipment.

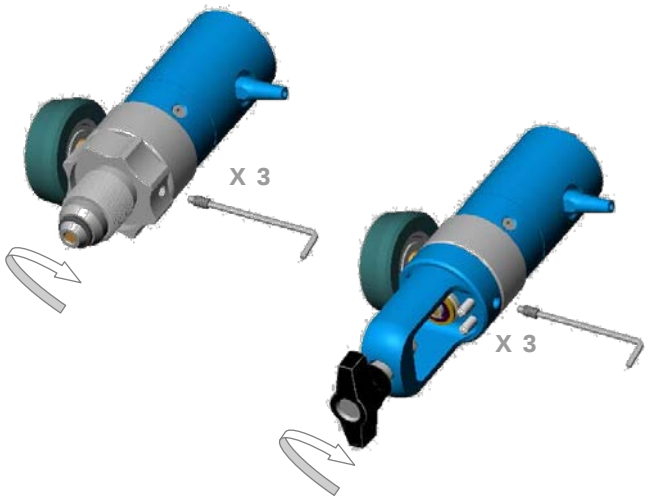
13.0 Procedures for Servicing

13.1 Cylinder Connector Removal

a) Disconnect the regulator from the gas supply.

b) Remove the *Cylinder Connector* by removing the 3 x *M4 Dog Point Screws* holding it to the *Input Body*.

Rotate the Cylinder Connector to allow access to each of the 3 screws that are equally spaced around the Regulator Input Body.



13.2 Cylinder Connector Cleaning

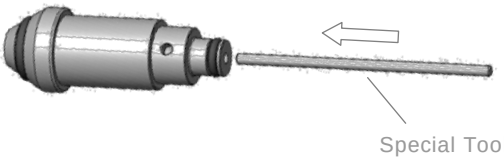
a) Remove the cylinder seal (O-ring or Bodok seal) and discard.

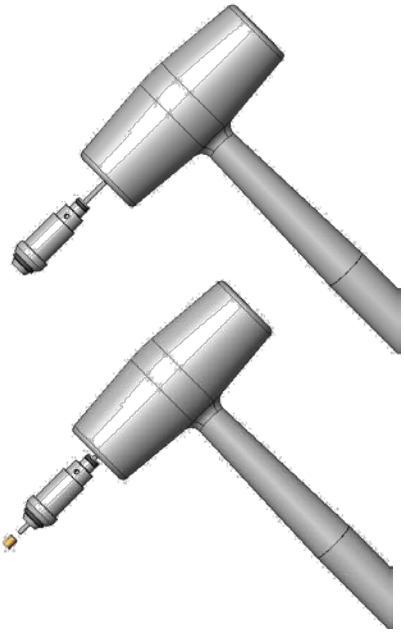
b) Remove the *Input Probe Seal* and discard.

c) Pass the *Filter Punch* provided in the *Service Tool Kit* into the *Input Probe* as illustrated and tap out the 40 micron filter.

d) Clean the *Input Probe* using a lint free wipe, a lint free swab and isopropyl alcohol.

Contamination of the Regulator Input Port from debris and hydrocarbons is a common cause of oxygen regulator incidents. Ensure that this area is completely free of debris and hydrocarbons before re-assembling the regulator.



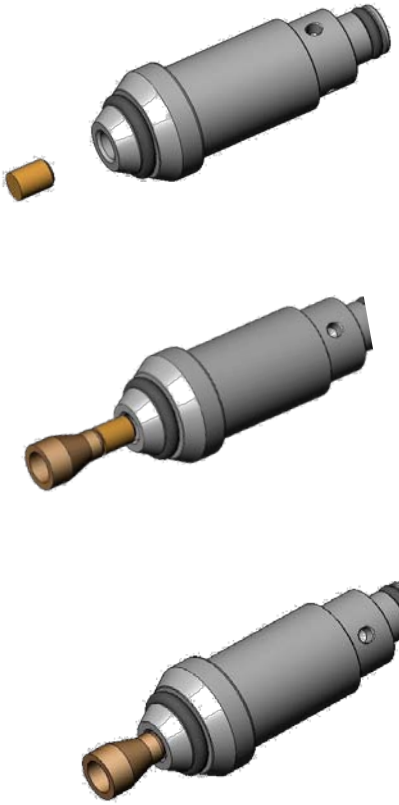


13.3 Fitting a New Filter

a) Fit a new *Input Filter* using the special tool provided. Compress the filter in place in an engineering vice or press. When properly inserted the filter should be below the front edge of the cylinder connector.

Ensure the engineering vice is clean. Additionally, lay a piece of lint free wipe over the top of the vice (not shown) before offering the Input Probe and Input Filter up to it. This will prevent contamination of the Input Filter from oils that might be on the vice.

b) Fit new *O-ring Seals*.



13.4 Cylinder Contents Gauge Removal

Early models of the regulator have a threaded Cylinder Contents Gauge, which can be removed using a ½"AF slimline spanner. The procedure below provides for the removal of current swivel type Cylinder Contents Gauges.

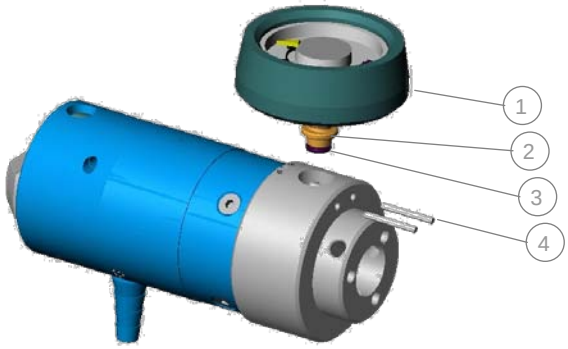
a) Remove the *Cylinder Connector* as outlined in Section 13.1

b) Turn the regulator upright, press the *Cylinder Contents Gauge* in and the two *Dowels* holding the *Cylinder Contents Gauge* in place will drop out.

c) Remove the *Cylinder Contents Gauge.*

d) Remove and discard the *Cylinder Contents Gauge O-ring.*

e) Fit a new *Cylinder Contents Gauge O-ring*.



13.5 Output Connector Removal

a) To remove the output connector use an 8mm AF spanner. This is not required as part of the service procedure.

Ident	*Pt. No.*	*Description*	*Qty*
1	*303 0030*	*Rubber Boot for Cylinder Contents Gauge*	*1*
2	*303 0041*	*Cylinder Contents Gauge*	*1*
3	*212 0093*	*O-ring, Cylinder Contents Gauge*	*1*
4	*208 0018*	*Dowel, 1.5dia x 14*	*2*
5	*602 0086*	*Flowmeter Output Tubing Nipple*	*1*
6	*212 0014*	*O-Ring,8 x 1.5, Viton*	*1*

13.6 Main Body Disassembly

a) Remove the rating label from the regulator waist.

b) Compress the regulator in an engineering vice using the special end caps provided in the *Service Tool Kit*.

Ensure the engineering vice is clean. Additionally, lay a piece of lint free wipe over the top of the vice before offering the regulator up to it. This will prevent contamination of the regulator from oils that might be on the vice.

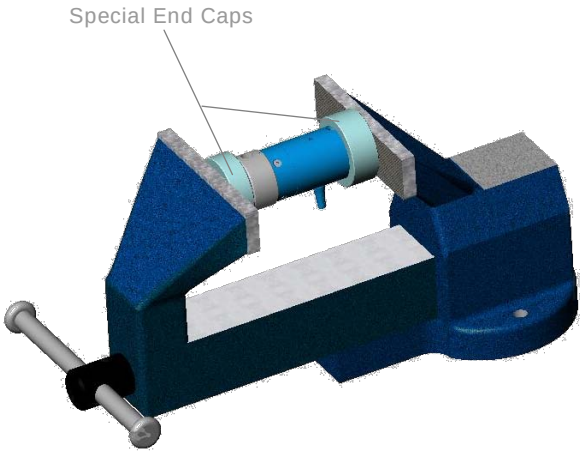
c) Compress but don't over tighten the regulator in the vice.

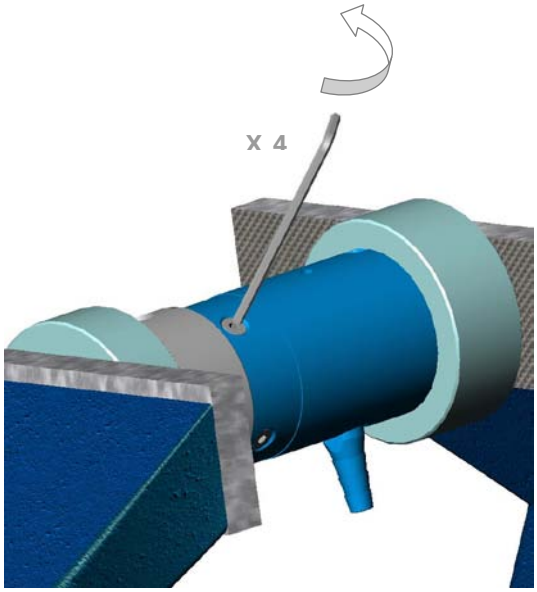
d) Remove the 4 output body retaining screws. Slowly release the vice until the regulator is no longer under compression and can be withdrawn.

e) When re-assembling the regulator, reverse the above steps.

Before fully compressing the assembly, take care to align the screw holes in the Regulator Output Body with those in the Regulator Input Body.

Ensure that the Output Body and the Input Body are oriented such that the Cylinder Contents Gauge and the Output Tubing Nipple are 180^{o} out of alignment with each other.





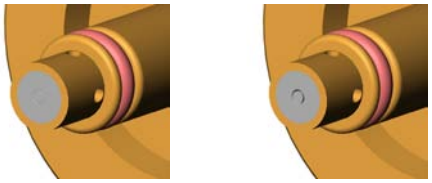
13.7 Piston O-Ring Replacement

a) Remove the two piston o-rings.

b) Inspect the quality of the Piston Seat and replace the Piston Sub-assembly (Piston Seat not available on its own) if the Piston Seat is damaged.

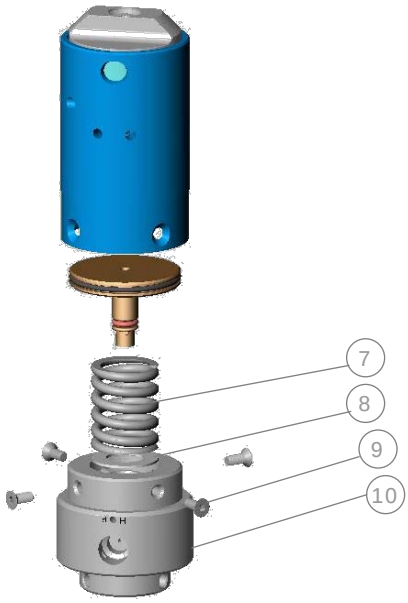
The Piston Seat is a key element in the safety and performance of a medical gas regulator, it is essential that it is kept clean and in good condition.

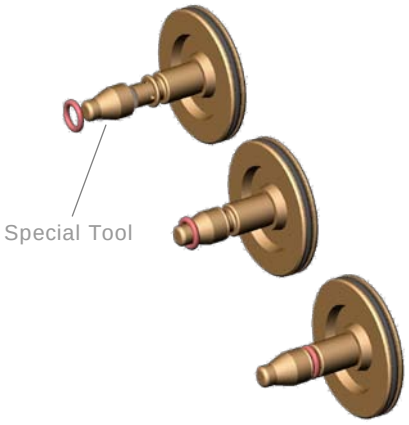
It is normal for the Piston Seat to have a witness mark but deformation should not be excessive. The images below offer a guideline as to what is acceptable and what is not. A damaged seat will offer poor pressure regulation. If in doubt, replace the piston sub-assembly



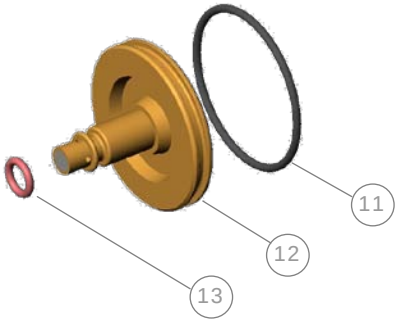
c) Clean the piston with a lint free wipe, a lint free swab and Isopropyl Alcohol.

d) Fit new piston O-rings. When fitting the smaller, silicone o-ring use the special tool provided as illustrated.





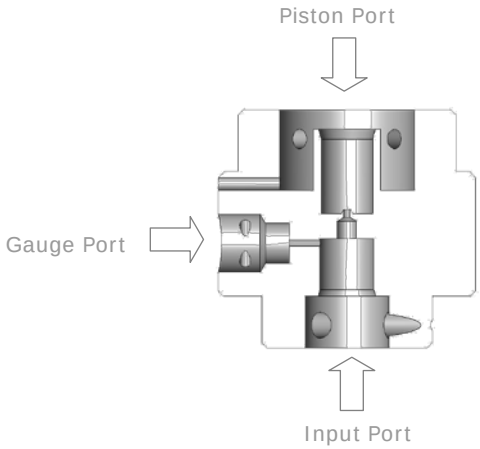
Ident	*Pt. No.*	*Description*	*Qty*
7	*213 0003*	*Spring, Regulator, 58 psi*	*1*
8	*207 0006*	*Washer, M10, SS*	*1*
9	*201 0020*	*Screw, M3 x 8 CSK, SS*	*4*
10	*602 0071*	*Regulator Input Body*	*1*
11	*212 0006*	*O-ring, 29.87 x 1.78, Viton*	*1*
12	*604 0045*	*Regulator Piston & Seat Sub-Assembly*	*1*
13	*212 0009*	*O-ring, 4.48 x 1.78, silicone*	*1*



13.8 Regulator Input Body Cleaning

a) Clean the inside of the Regulator Input Body using a lint-free wipe, a lint-free swab and isopropyl alcohol. Pay particular attention to the high pressure gas inlet port, gauge port and piston port areas. Check the ports using an appropriate UVA black light source (refer Section 8).

Contamination of the regulator input port from debris and hydrocarbons is a common cause of oxygen regulator incidents. Ensure that this area is completely free of debris and hydrocarbons in accordance with Section 8 of this manual before re-assembling the regulator.



13.9 Flowmeter Disassembly/Re-assembly

a) Remove the *M4 Button Head Screw* that retains the *Flow Plate Carrier Assembly*.

b) Remove the *Flow Plate Carrier Assembly*. Remove the small *Output O-ring Seal* and discard along with the *Compression O-ring* that sits immediately below the *M4 Button Head Screw*.

Do not do disassemble the Carrier Plate Assembly unless there is reason to believe that the filter has become contaminated or one of the flow orifices has been compromised.

c) Press the *Drive Shaft* through the *Output Body*. The *Control Knob* and *Drive Shaft* will come away from the *Output Body*. Leave the white *Control Knob and Output Sliders* in place.

Take care not to loose the Detent Balls when the Control Knob comes away from the Output Body.

d) Remove and discard the two *Drive Shaft O-rings*. Clean the *Drive Shaft* using a lint-free wipe, lint-free swab and isopropyl alcohol. Fit two new *Drive Shaft O-rings and smear each with a thin film of Krytox lubricant*.

Only a very small amount of lubricant is required. Do not over-lubricate the shaft.

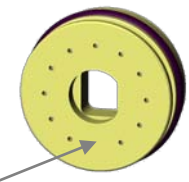
e) Clean the *Output Body* using a lint-free wipe, lint-free swab and isopropyl alcohol.

f) Fit a new *Output O-ring into the Output Slider*.

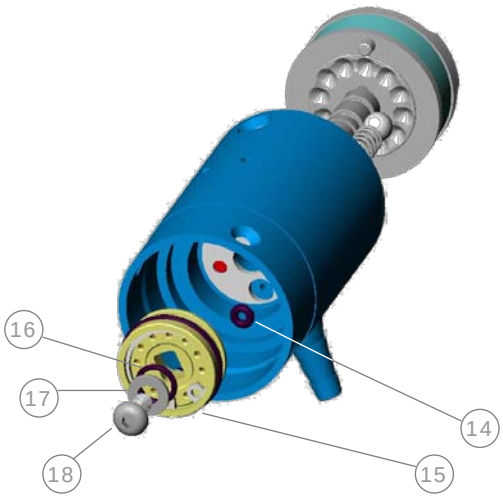
g) Hold the *Output Body* upright. Refit the *Detent Springs* and *Detent Balls*. Carefully lower and compress the *Control Knob* and *Drive Shaft* down onto the *Detent Balls*. Keeping the assembly compressed in your hand, turn the *Control Knob* around to show the zero position.

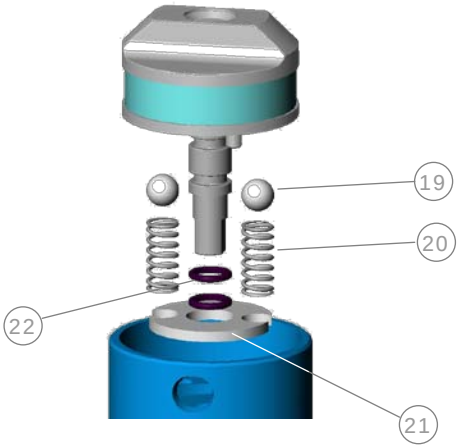
h) Keeping the assembly compressed in your hand, turn the *Output Body* over and refit the *Flow Plate Carrier Assembly* ensuring that it is oriented correctly. Firmly secure the assembly with the *M4 Button Head Screw*, *M4 Washer* and new *Compression O-ring*.

It is possible to fit the Carrier Plate Assembly 180° out of phase. When replacing the Flow Plate Carrier Assembly ensure that the Control Knob is set at the zero position and the 'no-hole' position on the carrier plate (refer illustration below) is fitted adjacent to the Output O-ring (i.e. no flow at zero).



The 'no-hole' position corresponds to zero flow





Ident	Pt. No.	Description	Qty
14	212 0015	O-Ring, Output Seal	1
15	604 0025	Range A Flowplate Carrier Assembly	1
15	604 0027	Range C Flowplate Carrier Assembly	1
15	604 0028	Rande D Carrier Plate Assembly	1
15	604 0044	Range E Carrier Plate Assembly	1
16	212 0017	O-Ring, Compression	1
17	207 0007	Washer, M4	1
18	201 0028	Screw, M4 Button Head	1
19	214 0003	Detent Ball	2
20	213 0007	Detent Spring	2
21	602 0095	Control Knob Slider	1
22	212 0041	O-Ring, Drive Shaft	2

Rotate the Cylinder Connector to allow access to each of the 3 screws that are equally spaced around the input body.

13.10 Regulator Reassembly

a) Before reassembly, check all internal parts that come into contact with the gas path are clean and free from debris or hydrocarbon contamination using an appropriate UVA black light source (refer Section 8).

b) Fit the *Main Spring* into the *Regulator Input Body*.

c) Smear a thin film of Krytox lubricant around the large piston o-ring.

Only a very small amount of lubricant is required. Do not over-lubricate the piston.

Use only Krytox lubricant. Under no circumstances should any other lubricant or grease be used.

d) Assemble the Piston into the Regulator Output Body.

When assembling the piston, offer it up at an angle to begin with then press it firmly back until the piston can go back no further and the piston shaft is square to the back face of the regulator output body.

e) Smear a thin film of Krytox lubricant around the small piston o-ring.

Only a very small amount of lubricant is required. Do not over-lubricate the piston.

Use only Krytox lubricant. Under no circumstances should any other lubricant or grease be used.

f) Carefully offer the *Regulator Output Body* and *Piston* up to the *Regulator Input Body* and *Main Spring*. Push together until the *Piston* is sitting on the *Main Spring*.

g) Using an engineering vice with the special end caps provided as part of the Service Tool Kit (refer Section 13.6), compress the main spring.

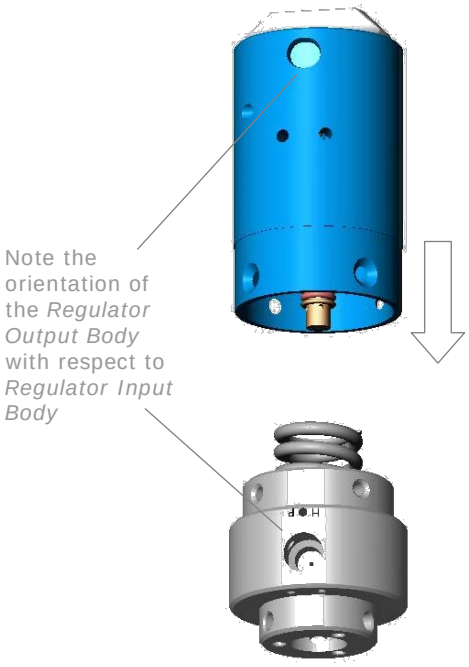
Before fully compressing the assembly, take care to align the screw holes in the Regulator Output Body with those in the Regulator Input Body.

h) Apply a thin film of *Loctite 222 Thread Locking Compound* to each of the 4 countersunk securing screws and tighten in sequence. Release the engineering vice and remove the regulator.

i) Refit the *Cylinder Contents Gauge*. Fit the 2 x retaining dowels (refer Section 13.3).

Be careful to retain both dowels in place until the Cylinder Connector is refitted.

j) Refit the *Cylinder Connector* and *Input Port Connector* to the *Regulator Input Body*. Fit the 3 x M4 Dogpoint screws that retain the *Cylinder Connector* (refer Section 12.1).



14.0 Procedures for Functional Check

Test Equipment Required:

	Range A	Range E	Range C	Range D
Calibrated flowmeter, FSD 18 l/min, accuracy +/- 5% of reading, resolution 0.1 l/min	✓		✓	✓
Calibrated flowmeter, FSD 400 ml/min, accuracy +/- 5% of reading, resolution 0.1 ml/min	✓	✓	✓	
Calibrated flowmeter, FSD 100 ml/min, accuracy +/- 5% of reading, resolution 0.1 ml/min	✓	✓		

14.1 Flow Rate Test

a) Connect the dial flow regulator to a 100 Bar pressure source and turn the supply on.

If a variable high pressure source is not available then use a full cylinder charged to 137 Bar. Input pressure has a marginal effect on the output flow and some consideration should be given to this when checking the flows. Increase in input pressure corresponds to an increase in flow.

b) Connect the *Output Tubing Nipple* to an appropriate calibrated flowmeter and check the flow at each flow setting position.

c) Regulators should not need to be adjusted for calibration as a matter of routine, but should recalibration be required refer to Section 15.

14.2 Leak Test

Connect the dial flow regulator under test to a full cylinder. Set the dial flow regulator to zero flow position. Close the cylinder valve and monitor the *Cylinder Contents Gauge*. Leave the regulator for 10 minutes. If the *Cylinder Contents Gauge* reading drops then the regulator has a leak requiring repair. Refer section on Troubleshooting.

15.0 Flow Calibration

Check the condition of the regulator piston before attempting to recalibrate the regulator.

It is not possible to calibrate individual flow settings. Adjusting the output pressure using the procedure below will impact the flowrates at all flow settings.

a) Follow the steps given in Section 14.1 – Flow Rate Test. Record the flow readings.

b) Turn off the cylinder and remove the dial flow regulator.

c) Remove the *Cylinder Connection* according to Section 13.1.

d) Remove the 3 x *M3 Locking Screws* from the *Regulator Input Body* using a 2mm AF Allen Key.

e) Adjust in turn each of the 3 x *Adjusting Screws* by ¼ turn only. Viewed from the top of the screw, clockwise increases the flow rate.

All 3 screws must be adjusted in turn and by the same amount. Work in ¼ turn steps only.

f) Reconnect the *Cylinder Connector*. Test according to Section 14.1 – Flow Rate Test.

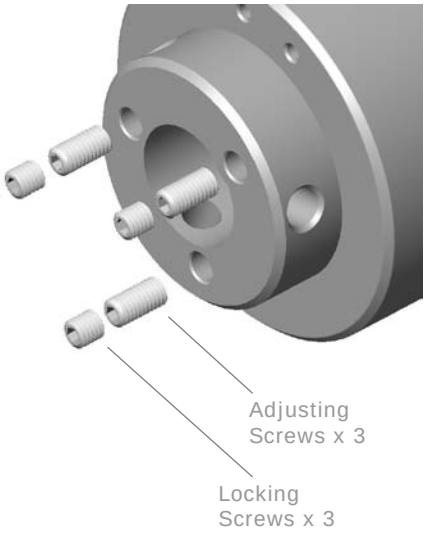
g) Repeat steps b) through f) until the dial flow falls within specification.

h) Remove the *Cylinder Connection* according to Section 13.1.

i) Smear a thin film of *Loctite 222 Thread Locking Compound* onto each of the 3 x *M3 Locking Screws* and screw them into the *Regulator Input Body* until they just touch the *Adjusting Screw*.

Do not overtighten as this will move the Adjusting Screws and change the flow calibration.

j) Reconnect the *Cylinder Connector*. Test according to Section 14.1 – Flow Rate Test.



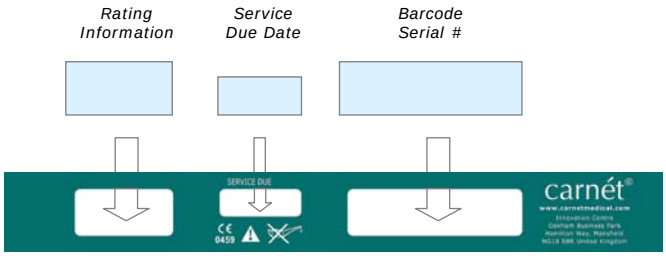
16.0 Fitting the Rating Label

a) A new rating label membrane is provided as part of a dial flow service kit. Use the old barcode and rating label inserts.

If you have old style printed rating labels call Customer Services who will arrange to send you a set of the new insert type labels.

b) Create a Service Due Date insert using a Dymo 6mm Tape and insert it behind the membrane panel. Use the format Month + Year (e.g. FEB 08) and make the date 4 years from the date the regulator is serviced.

Take care when fitting the membrane overlay not to contaminate the adhesive with your fingers as this reduces the effectiveness of the adhesive.



17.0 Troubleshooting Guide

Symptom	Possible Cause	Remedy
Gauge bent or damaged	Probable impact (e.g. cylinder dropped)	Replace the gauge
Gauge doesn't zero, stuck at full or gives false readings	1) Damaged gauge 2) Cylinder contents gauge o-ring misaligned (partially covers feed hole early models)	1) Replace gauge 2) Remove the gauge, replace the o-ring, replace gauge.
Gas leaks at cylinder connection	1) Cylinder valve face scored 2) Inlet seal (O-Ring or Bodok seal) damaged or missing	1) Replace cylinder 2) Replace inlet seal
Gas leak at union of cylinder connection and regulator input body	1) O-rings damaged 2) Input probe broken	1) Replace o-ring 2) Replace input probe
Gas leak at cylinder contents gauge port	O-Ring seal damaged	Replace o-ring
Over Pressure Valve activates, gas leak from OPV exhaust ports	1) Output pressure too high due to damaged piston 2) Spring adjusted too high 3) OPV seal damaged or not properly seated 4) Damaged Main Jet	1) Replace piston 2) Re-calibrate regulator 3) Replace the Output Body Assembly or return to service centre for repair 4) Replace Regulator Input Body and Regulator Piston

18.0 Service Parts, Kits & Tools

Parts are identified by Part Number throughout this manual and in most cases can be purchased individually. Service Kits include all parts required to service 10 x regulators in accordance with the instructions given in this manual.

Part #	Description
610 0057	Bodok Bonded Seal (Pack of 50)
610 0058	Bull Nose O-Ring Seal (Pack of 50)
610 056	Service Parts Kit (10 Dial Flow Regulator Pack)
610 0055	Service Tool Kit for Regulators and Dial Flow Regulators *Includes: Krytox Lubricant, Bull Nose O-Rings, Bodok Seals, Special End Caps Tools, O-Ring Applicator/Filter Compression Tool, Filter Punch*
610 0047	Krytox LC025 Oxygen Tolerant Grease
610 0046	Loctite 222 Thread Locking Compound
610 0054	UVA Black Light Source, 315nm – 400nm

19.0 Notes

This area is provided to enable you to write the things down that you have discovered that we 'should have made clear in the manual'. If you would like to let us know what these things are we will gladly add them to the next revision of the manual. Thank you in advance for your help in improving this manual.